

## MODELS OF ONTOGENETIC DEVELOPMENT

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*Abstract: The article presents a new theoretical concept of phenotypic development of a population and an individual. It is pointed out that deviations and fluctuations which are normal phenomena in biological development take place in ontogeny. Determinants, models and evaluation of multi-level ontogenetic development are described.*

*Key words: Multi-level ontogenetic development; Ontogeny.*

### Introduction

The main thesis of this work says that biological development in ontogeny takes place in a non-standard way. Therefore changes of developmental regularities. The thesis breaks decisively with the traditional description of the process of development.

The new theoretical concept on ontogenetic development presented in this article and called "multi-level ontogenetic development" provides more profound description of development regularities of both population and individual.

In this paper models of phenotypic and ontogenetic development are discussed and sets of theorems which describe them are formulated. They describe the theoretical structure of the concept of multi-level ontogenetic development of a population and an individual.

### Determinants of the Phenotypic Development

Figure 1 presents a general outline of the interaction of genetic and environmental factors which form a system, within the adaptive norm for a given population, in which the phenotypic formation of morphological features of particular genotypes is determined genetically in a quantitative way, and its image is the result of "selection" by these genotypes at the appropriate level of value  $V$  within the range of reaction norm. Magnitude  $V$  is an adaptive value determined on a pair, or more numerous set, of features which were used in the evolution of the phenotypic formation of features in the development. Therefore, one could say that the genetically determined reaction norm is the range of phenotypic reactions of a definite genotype manifesting itself in the form of various phenotypes, taking place as a result of interaction of a genotype with environmental factors. Adaptive norm is a more or less constant complex of features which guarantee environmental adaptation and are evidence of the genetic changeability within the population.

## Models of Ontogenetic Development

### *Model I. Stable development*

This model characterizes the first kind of phenotypic formation of features in the development. According to this model the course of ontogenesis of a population is determined by the framework of the adaptive norm. Organisms which belong to such a population always realize phenotypically the definite developmental path. In this type of ontogenetic development the organism always form their phenotypes on the middle level of the genetically given range of the reaction norm. The developmental path so determined corresponds in each interval of time to the optimum level of development. Therefore, organisms and population do not possess any ability of transition into other developmental levels and it is both into the ultra-optimum and sub-optimum levels. Hence the population (and individuals) develop in a stable way. This phenomenon fully justifies the name of model I in which one can clearly see that the population develops according to the genetically given level of development (Figure 2).

### *Model II. Progressive development*

This model presents a different, specific situation in the development, in which the population develops phenotypically along the lines of changing developmental levels. This process takes place as follows. The course of ontogenetic development is limited by an adaptive norm. The population (and organisms) realize phenotypically the developmental path which in the subsequent periods of ontogenesis is situated on increasingly higher developmental levels. Therefore, the phenotypic formation of features takes place in increasingly higher ranges of the reaction norm. In other words, this model illustrates the phenomena of "leaping" in the subsequent phases of development on to developmental levels higher than the previous ones. That is why the most essential feature of the discussed model is considered to be the progression of development in relation to the genetically given level of development (Figure 3).

### *Model III. Regressive development*

This model presents an opposite situation to that described in model II. Within the adaptive norm the population (and individuals) form their developmental path selecting in the subsequent phases of ontogenesis increasingly lower developmental levels. The developmental specificity of model III is shown by its regressive character manifested by a decrease, through passage, into the lower developmental levels, in respect of the initial level of genetically determined, developmental possibilities (Figure 4).

### *Model IV. Multi-level development*

Model IV precisely characterizes the actual process of the course of ontogenetic development. It permits the possibility of simultaneous occurrence of all the three situations, described in models I, II, and III in the process of phenotypic development of the population. This complex developmental situation may be characterized in the following way. Ontogenetic development of a population takes place within the adaptive norm. Organisms taking part in the complex process of development form their developmental paths in various phases of ontogenesis on various developmental levels. Thus the phenomena of simultaneous shift of individuals in the range of adaptive norm on various developmental levels takes place with the utilization various (often full)

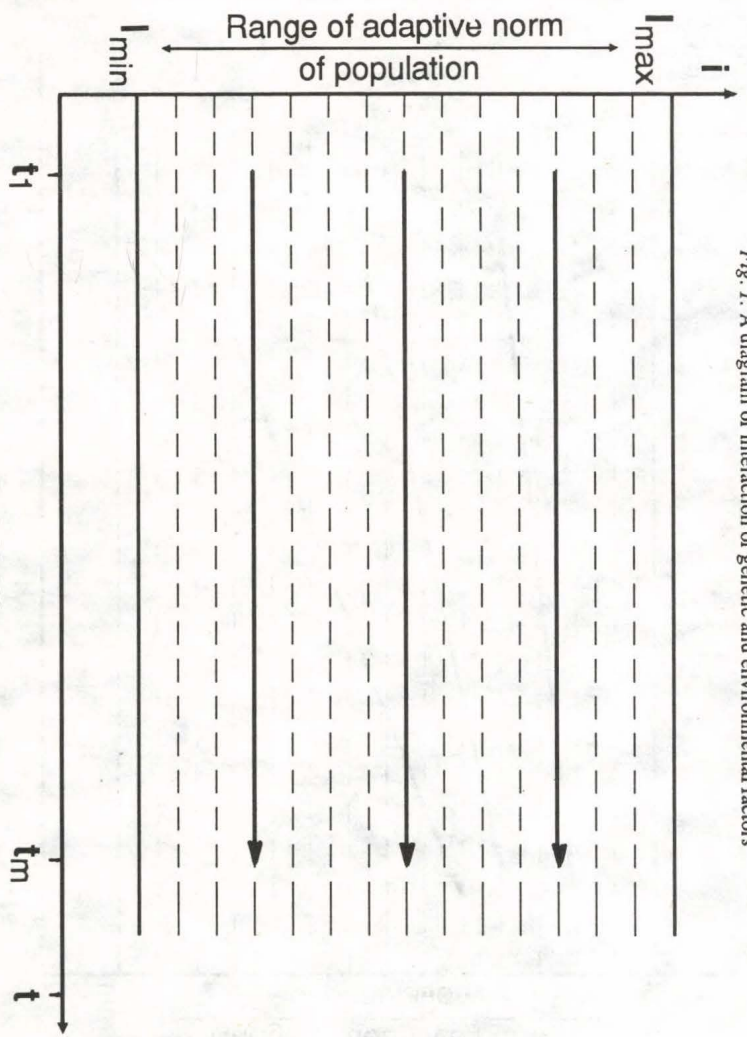


Fig. 2: Model I.

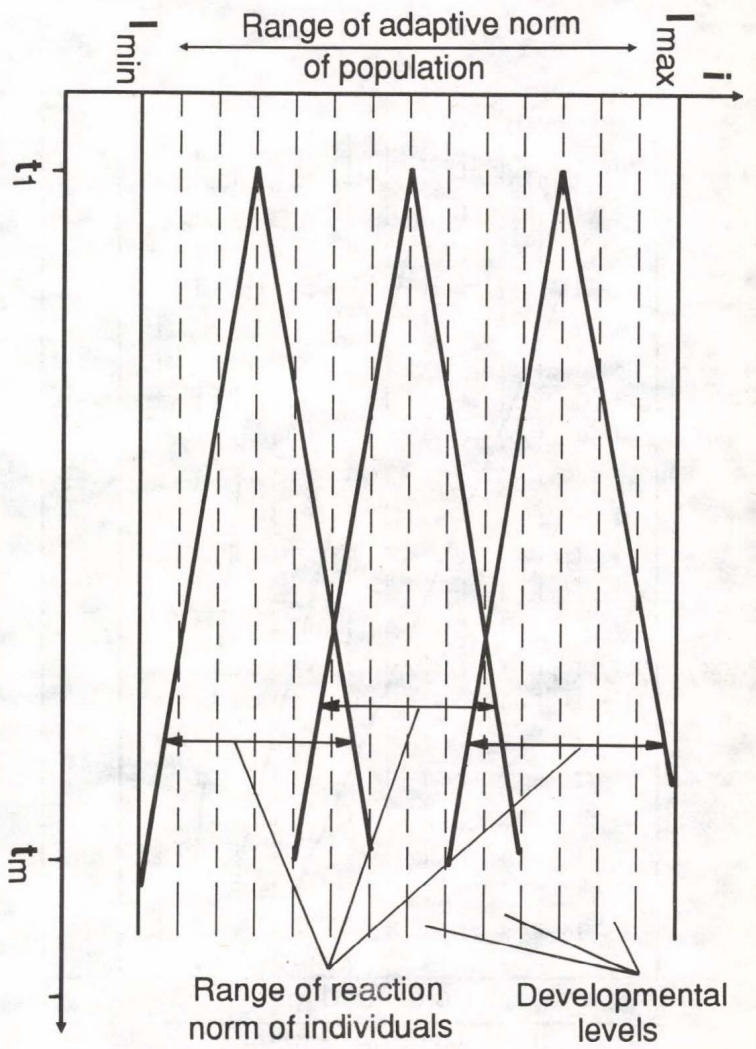


Fig. 1: A diagram of interaction of genetic and environmental factors

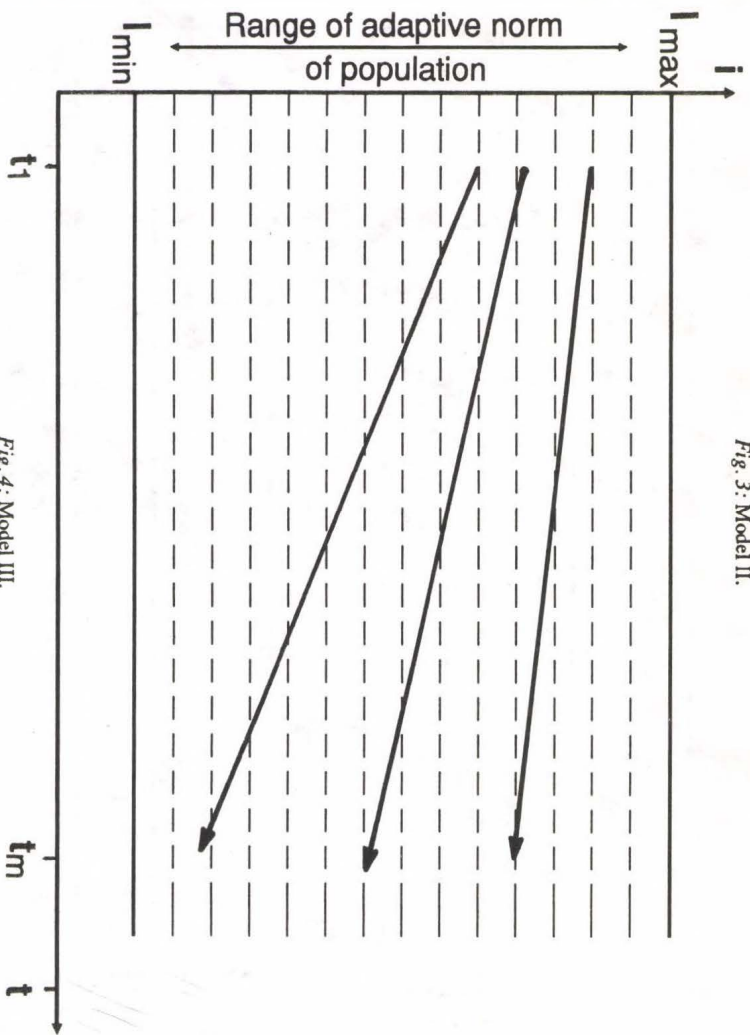


Fig. 4: Model III.

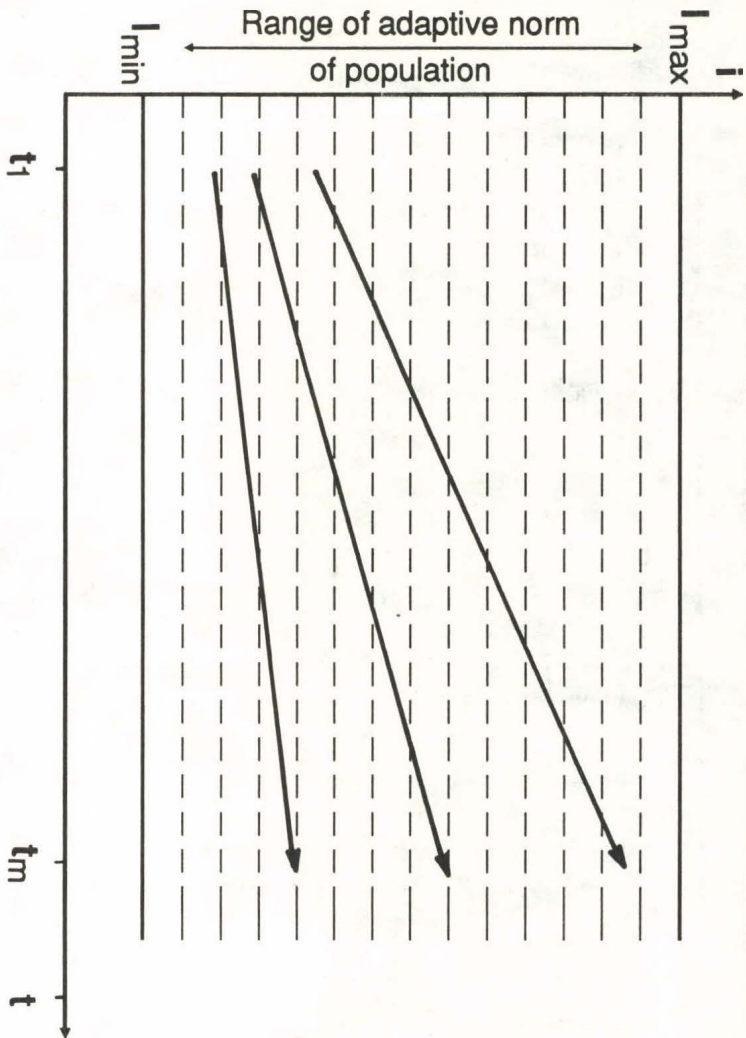


Fig. 3: Model II.

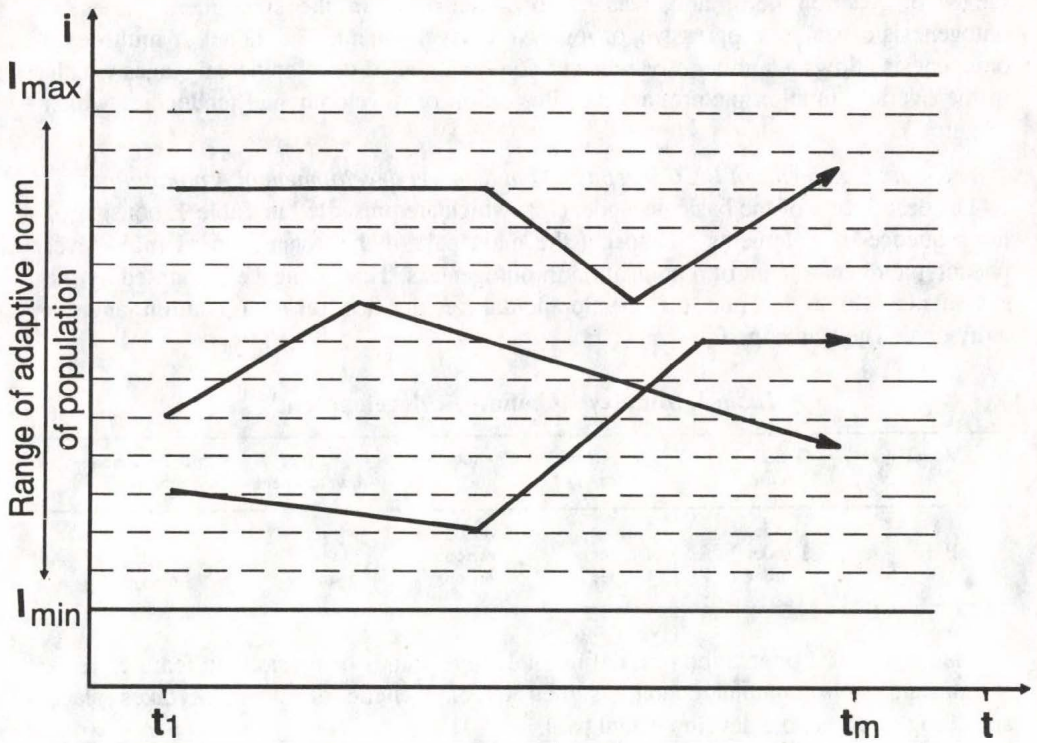


Fig. 5: Model IV.

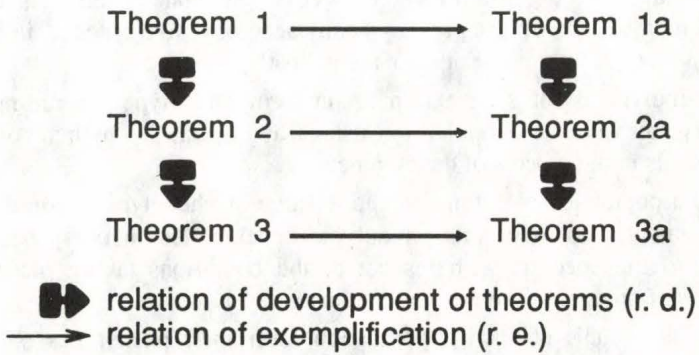


Fig. 6: Theorems

ranges of reaction norm and, what follows transition in the subsequent stages of ontogenesis of stable, progressive, or regressive development. The model of multi-level ontogenesis allows a number of variants of combinations of developmental stages which, in the overall complex picture, are the illustration of developmental tendencies which (Figure 5).

*The main statements of the Conception of multi-level development of A population*

The description of the basic dependencies, which are presented in Table 1. consists of the sequence of statements composing the main part of the conception of multi-level phenotypic development of a population in ontogenesis. This sequence is marked by the statements which describe the developmental regularities of a population and an individual. They state the following:

**Table 1. Multilevel phenotypic development**

Model	Genetic factor	Environmental factor	Phenotypes	Path of development	Number of phenotypic variants
I	1-order	2-order	various	one	one
II, III	1-order	1-order	various	one	many
IV	1-order	1-order	various	many	many

*Theorem 1.* If a population of a definite adaptive values of phenotypic features lives in constant environmental conditions then its ontogenetic development takes place according to one stable developmental path.

*Theorem 1a.* Individuals of this population form their phenotypes according to the developmental pattern of the population and their developmental paths are always located on the optimum of development.

*Theorem 2.* If a population with phenotypic features of definite adaptive value encounters advantageous, or disadvantageous environmental conditions, then its ontogenetic development takes place phenotypically according to a specific, in case (1): progressive, or in case (2): regressive developmental path.

*Theorem 2a.* Individuals of such a population form phenotypes according to the developmental pattern of a population using appropriately higher or lower developmental levels in the process of development.

*Theorem 3.* If a population of definite adaptive value of phenotypic features lives in changing environmental conditions its phenotypic development in ontogenesis takes place according to the specific, with respect to the conditions taking place in the subsequent phases of ontogenesis, developmental path.

*Theorem 3a.* Individuals of such a population form their phenotypes on various developmental levels depending on the type of environmental conditions taking place in the subsequent phases of ontogenesis (Fig. 6).

## Conclusions

The conducted characterization of models of ontogenetic development, tabular arrangement of dependencies taking place within the suggested concept, and the fundamental theorems of this concept enable the following conclusion to be drawn:

1. The concept of multi-level phenotypic development of a population makes possible the execution of the phenotypic description of the development of a population closer to the actual course of ontogenesis; this means that the multi-level interpretation gives a non-homogeneous structure of population development, which is attended by the possibility of showing the contribution of individual development in the formation of the phenotypic picture of population development (model IV, theorems 3 and 3a).

2. It guarantees the description of the specific course of the development of population in ontogenesis (model I, II, III, theorems 1, 1a, 2, 2a).

3. Each of the models together with the corresponding set of theorems illustrates the regularity of ontogenetic development of a population and an individual, whereas the developmental deviations (e.g. the change of developmental level) is explained as a natural reaction of an individual to the influence of environmental conditions.

4. The concept of multi-level phenotypic development of a population makes possible the formulation of theorems which describe the fundamental regularities of ontogenetic development.

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